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The effects of warming fluid on hypothermia, blood transfusion in hip replacement

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Abstract

Aim: Inadvertent intraoperative hypothermia is a common problem but it can be avoided. Passive isolation and active heating methods are used to prevent inadvertent intraoperative hypothermia. The aim of this study was to investigate the effect of warming intravenous fluids on hypothermia, blood loss, and transfusion in total hip replacement surgery.

Material and Methods: After the approval of the ethics committee was obtained, the files of 69 patients who underwent total hip replacement operation between December2014 and July2015 as well as the hospital's data system were analyzed retrospectively. Nine patients with missing data were excluded. We included in the study 60 patients aged 30-90 years, with ASA1-3,weighing 50-100kg, normal coagulation tests normal and spinal anesthesia. The patients were divided into two groups as Group1(n=28), in which the intraoperative intravenous fluids were warmed and Group2(n=32),in which liquids were not warmed. Groups were analyzed with regard to hypothermia, amount of bleeding, transfused blood, amount of fluid injected intraoperatively, and pre-postoperative hemoglobin-hematocrit changes.

Results: Hypothermia was observed in both groups. In Group 1, body temperature was significantly higher than Group 2. The amount of fluid given(lt) and the amount of blood loss(ml) were both significantly lower while postoperative hemoglobin-hematocrit values were significantly higher in Group 1($p < 0.05$). No significant difference was found between the two groups in terms of blood transfusion.

Discussion: Hypothermia is a problem in hip replacement surgery. Although we have used the convective air warming system and heated intravenous fluids, we observed intraoperative hypothermia in both groups. Therefore, we suggest that temperature monitoring and patient warming should be a routine procedure in the pre-intra-postoperative phase.

Keywords

Hypothermia; Fluid warming; Hip replacement

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Introduction

Inadvertent intraoperative hypothermia is the decrease of body temperature to levels below 36°C and it is a common problem of surgery and anesthesia [1,2]. Intraoperative hypothermia is associated with physiological and clinical outcomes [3,4]. Myocardial events that increase mortality, surgical wound infection, intraoperative blood loss, length of recovery in the post-anesthesia care unit and length of hospital stay increase with hypothermia [5]. Passive heating systems (closed or semi-closed anesthesia circuits increasing the ambient temperature) and active heating methods (electric blankets, blankets or beds with warm water cycles, hot air blowing systems, heated intravenous fluids and irrigation fluids, etc.) are used for inadvertent intraoperative hypothermia [6]. One of the active heating methods is the use of heaters to warm up intravenous fluid, blood, and blood products. Intravenous fluids (500 ml or more) and blood products should be warmed to 37°C using a fluid warming device [7]. The use of an intravenous fluid warmer is recommended in the NICE 2008 guideline. The aim of this study was to investigate the effects of warming intravenous fluids on intraoperative hypothermia, hemodynamics, hemorrhage and blood transfusions in total hip replacement, where the bleeding was high and intravenous fluids were used at high volumes.

Material and Methods

This study was carried out retrospectively on 69 patients with total hip replacement operation between December 2014 and July 2015 at XXX University, Atatürk Education and Research Hospital Orthopedics clinic, after obtaining the approval of the Ethics Committee of Tepecik Education and Research Hospital. Nine patients with missing data were excluded from the study. Sixty patients aged between 30-90 years, with ASA 1-3, weighing 50-100 kg, normal coagulation tests and spinal anesthesia were included in the study. Patients with preoperative body temperature ≥38°C and ≤35.5°C, previous head trauma, abnormalities in coagulation tests (PTT≥35s, PT elongation of 70%, platelets ≥100,000 / mL), and using aspirin or anticoagulants within 2 weeks prior to surgery and those with insufficient data were excluded from the study. Patients with total hip replacement surgery are warmed in the operating room with the convective air warming system (Nellcor-Warm Touch 5300A Patient Warming System). In addition, intravenous blood, blood products, and fluid can be warmed (Astoflo Plus eco blood and infusion warmer, max.43°C). In our study, the patients were divided into two groups according to their heating methods: the ones provided with warmed intravenous fluids constituted Group 1 (n = 28), and Group 2 (n = 32) in which liquids were not warmed. We have two operating rooms for orthopedic surgery and only one intravenous fluid warmer. So we could not use it in all patients. Temperatures were measured intraoperatively from the tympanic membrane with an infrared thermometer. Demographic data of the patients such as age, gender, BMI, ASA, and other diseases were recorded according to the preoperative anesthesia form and intraoperative observation paper entered by the anesthesiologist. Duration of operation, heart rate (HR), noninvasive arterial pressure (NIBP), oxygen saturation ($Sp0_2$), and body temperature, when the operation commenced and again HR, NIBP, $Sp0_2$, and body temperature intraoperatively every 30 minutes, as well as intraoperative fluid volume, aspiration total blood volume, blood transfusion and the amount of erythrocyte suspension were recorded from anesthesia observation paper. Preoperative and postoperative hemogram results were obtained from the hospital registry system, hemoglobin and hematocrit results were recorded. In our hospital, operating room temperature is maintained at 23°C with a central system. Since all orthopedic operations are performed in two certain rooms assigned for surgical operations, it was assumed that the room temperature was constant throughout the operations.

Statistical analysis

Sample-size estimation was based on reference to published articles and according to the total number of hip operations for 1 year. The statistical analysis of the data was done with IBM SPSS Statistics Version 24 program. The Pearson Chi-Square, Fisher's Exact test and Chi-Square trend analysis were used for comparing categorical data between the groups; and in statistical analysis, the Mann Whitney and Independent sample t-test were used for the comparison of continuous data between groups, according to the normal distribution of data. Preoperative and postoperative changes of HR, NIBP, SpO2 and body temperature were evaluated by the Wilcoxon Signed Ranks analysis and paired sample t-test. The results of the data were accepted within a 95% confidence interval and $p < 0.05$ was considered statistically significant.

Results

Sixty patients (33 males,27 females) aged 32-88 years (64.77 ± 12.92 years) were included in the study. There was no difference between Group 1 and Group 2 in terms of demographic data such as ASA, gender, age, presence of cardiovascular disease, and BMI values (Table 1).

In our study, the rate of development of hypothermia increases with age. Hypothermia was significantly higher at the age of 46-59 and ≥60 years(p:0,034-p:0,002).

There was no difference between the groups in terms of intraoperative HR and NIBP, while SpO2 values in Group 1 were significantly higher at 90 and 120 minutes. These values are statistically significant however, this difference is not clinically important, since it is within normal limits. In Group 1, body temperature has dropped below 36°C at 60th minute, in Group 2 at the 30th minute. However, body temperatures were significantly higher in Group 1 at the 30th, 60th and 90th minutes of the surgery (Table 2, Figure 1).

When the total amount of fluid given peroperatively was evaluated, it was found to be significantly lower in Group 1. The amount of bleeding was also significantly lower in Group 1. There was no difference between the groups in terms of blood transfusion administered according to the physician's anticipation.

There was no difference between the groups in terms of preoperative hemoglobin and hematocrit values, while postoperative hemoglobin and hematocrit values were significantly higher in Group1. Preoperative and postoperative hemoglobin-hematocrit exchanges were significantly lower in Group 1 than Group 2 (Table 3).

Table 1. Evaluation of the groups in terms of demographic characteristics

GROUPS	GROUP 1 (n = 28) (Mean ± SD)	GROUP 2 (n = 32) (Mean ± SD)	p
Age (years)	64,7±11,84	64,83±14,12	0,969
Gender (M / F)	16/14	17/13	0,121
BMI	25,24±3,14	24,64±3,72	0,505
ASA (I / II / III)	9/17/4	12/15/3	0,241
Operation duration (min)	112,17±18,18	114,5±10,78	0,287
Patients with cardiovascular disease	22	20	0,523

ASA: American Society of Anesthesiologists, Mean ± SD: Mean ± standard deviation, M / F: Male / Female, BMI: Body mass index

Table 2. Evaluation of the groups according to the SpO_2 values and body temperature

	Group 1 SpO_2	Group2 SpO_2	p	Group 1 ºC	Group 2 0C	p
0.min	98,33±1,92	97,27±1,74	0,065	36,38±0,34	36,23±0,27	0,069
30.min	98,7±1,29	97,37±1,88	0,055	36,05±0,22	35,9±0,29	0,027*
60.min	97,77±2,98	97,9±1,56	0,593	35,92±0,28	35,74±0,28	0,008*
90.min	98,5±1,68	97,4±1,65	0,011*	35,89±0,24	35,62±0,26	0,000*
120.min	98,38±1,61	96,93±1,21	0,006*	35,92±0,46	35,7±0,27	0,164

*p<0.05

Table 3. Evaluation of the groups according to intravenous fluid

GROUPS	GROUP 1 (n = 28) (Mean ± SD)	GROUP 2 (n = 32) (Mean ± SD)	p
Perioperative i.v. fluid (liters)	2286,67±487,59	2780±727,49	0,002*
Bleeding (ml)	511±208,22	750,5±183,49	0,000*
Blood transfusion	1,27±0,46	1,35±0,49	0,604
Preoperative hemoglobin (g / dl)	12,33±1,35	12,31±1,36	0,947
Postoperative hemoglobin (g/dl)	10,6±1,05	9,7±0,88	0,001*
Preop-postop hmg exchange (%)	13,76±5,55	20,73±6,73	0,000*
Preoperative hematocrit	35,8±3,91	36,35±3,18	0,348
Postoperative hematocrit	31,67±2,68	30,15±1,6	0,012*
Preop.-postop. htc exchange (%)	11,22±4,67	16,63±6,14	0,000*

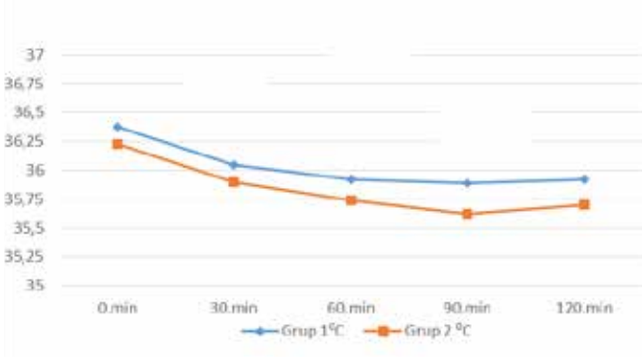

Figure 1. Evaluation of the groups according to body temperature replacement, hemorrhage and hemoglobin-hematocrit values

Discussion

In our study, which included 60 patients with total hip replacement surgery, we aimed to evaluate the effect of warming intravenous fluids on hypothermia (‹36ºC), amount of bleeding, preoperative and postoperative hemoglobin-hematocrit changes and amount of blood transfusion.

The risk of inadvertent intraoperative hypothermia has been reported in a wide range (50-90%) [8]. Despite the necessary precautions, unpreventable heat loss is a common condition in patients undergoing anesthesia, regardless of the type of anesthesia selected [9]. The causes of hypothermia were reported by Aksu et al. [10] in their study as follows: advanced age, ASA III and IV patients, interventions involving large body cavities, prolonged operation times, intraoperative excessive blood loss and fluid replacement, room temperature lower than 23ºC. In the same study, the age of hypothermic patients was found to be higher. Similarly, hypothermia was found to be significantly higher in the advanced age group, in our study.

In the study by Yokoyama et al. [11], out of 30 patients having a cesarean section under spinal anesthesia, one group was given intravenous fluids preheated at 41°C before infusion. And even during infusion, the fluid continued to be warmed with intravenous fluid warmers at 38°C. In the other group, fluids were given at room temperature. In the group with warmed fluids, the body temperature was significantly higher within 45 minutes after delivery. In the group, in which fluids were not warmed, hypothermia (<36ºC) started to be observed from the 15th minute on, following delivery. Woolnough et al. [12] divided 75 patients with cesarean section into 3 groups. The fluids were at room temperature in the first group, warmed up to 40-41ºC in heating units in the second group and warmed up to 42°C by means of a liquid heating system (Hotline) in the third group. In all groups, temperatures started to decrease after 60 minutes, but the lowest temperature was in the group where liquids were given at room temperature. Similarly in our study, there was a significant decrease in the group in which the fluids were not warmed.

Even in moderate hypothermia (<35ºC), physiological coagulation mechanisms are impaired, affecting platelet functions and inducing modifications in enzymatic functions. The decrease in platelet activity increases the bleeding and stimulates the need for transfusion [8]. Rajagopalan et al. [13] analyzed 14 studies and reported that moderate hypothermia (34ºC -36ºC) increased blood loss by 16% and increased blood replacement rate by 22%. In our study, blood loss was found to be significantly higher in the group without warmed fluids. There was no difference between the two groups in terms of blood transfusion.

Yi et al. [14] evaluated blood loss, blood transfusion, and preoperative/ postoperative hemoglobin change in major surgical operations (thoracic surgery and total hip operation) with passive isolation and active warming. Active warming was provided by convective air warmer system (43ºC). The upper part of the patient was warmed for 15-30 minutes before arriving at the operation room. The blanket was preheated and placed in the lower part of the patient in the operation room before induction. All patients were given fluids warmed at 37°C. Hypothermia was not observed in patients with active

warming. In addition, there was less blood loss and less preoperative and postoperative hemoglobin changes in this group. Similarly, in our study, preoperative and postoperative hemoglobin-hematocrit changes were observed to be less in the group in which intravenous fluids were warmed. Our patients are not warmed preoperatively, instead a hot air warming system is used after anesthesia induction, and the upper part of the patient is warmed with a blanket in total hip replacement surgery. In this study, that is how we can explain the development of hypothermia in both groups. However, this ratio is lower in the group where liquids are warmed.

Xu et al. [15] recommended to administer warm intravenous or skin irrigation solutions and to increase the ambient room temperature, as well as, to use external warming devices to prevent hypothermia in the elderly. Liu et al. [16] analyzed a total of 287 patients from 6 clinical studies and reported no statistical difference in thermal comfort, blood loss, or incidence of shivering and hypothermia between the air-free warming and forced-air warming groups. The air-free warming system was as effective as the forced-air warming system in patients undergoing joint arthroplasty.

There are some limitations in our study. Firstly, room temperatures are fixed at 23ºC by means of a central heating system. However, the temperature can be adjusted by a control unit. In our study it was assumed that the room temperatures were the same. Secondly, the sample size is rather small. Thirdly, blood loss was determined by the amount in the aspirator bag only. The buffer weights were not taken into account.

Conclusion

The present study revealed that hypothermia is an important problem in total hip replacement operation. We observed that hypothermia development, bleeding amount, preoperative, and postoperative hemoglobin-hematocrit changes were less in the case of warming intravenous fluids. In these patients, we suggest starting active warming in the preoperative phase and continuing in the intraoperative phase.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

1. Sessler DJ. Temperature monitoring, In: Miller RD, editors. Miller's Anesthesia, 8th ed. Philadelphia: Elsevier/Churchill Livingstone; 2014.p.1622-47.

2. Sessler DI. Perioperative heat balance. Anesthesiology. 2000;92:578–96. DOI:10.1097/00000542-200002000-00042.

3. Kumar S, Wong P, Melling A, Leaper D. Effects of perioperative hypothermia and warming in surgical practice. Int Wound J. 2005;2:192-204. DOI:10.1111/j.1742-4801.2005.00102.x.

4. Putzu M, Casati A, Berti M, Pagliarini G, Fanelli G. Clinical complications, monitoring and management of perioperative mild hypothermia: anesthesiological features. Acta Biomed. 2007;78(3):163-9.

5. Winkler M, Akca O, Birkenberg B, Hetz H, Scheck T, Arkiliç CF, et al. Aggressive Warming Reduces Blood Loss DuringHip Arthroplasty. Anesth Analg. 2000;91(4):978–84. DOI:10.1097/00000539-200010000-00039

6. Sessler DI. Temperature monitoring and perioperative thermoregulation. Anesthesiology. 2008;109(2):318-38. DOI:10.1097/ALN.0b013e31817f6d76.

7. Moola S, Lockwood C. The effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment: systematic review. JBI Libr Syst Rev. 2010;8(19):752-92. DOI:10.11124/01938924-201008190-00001.

8. Bilgin H. Inadverdent Perioperative Hypothermia. Turk J Anaesthesiol Reanim. 2017;45(3):124-6. DOI:10.5152/TJAR.2017.200501.

9. Doufas AG. Consequences of inadvertent perioperative hypothermia. Best Pract Res Clin Anaesthesiol. 2003; 17(4):535-49. DOI:10.1016/s1521-6896(03)00052-1.

10. Aksu C, Kus A, Gürkan Y, Solak M, Toker K. Survey on Postoperative Hypothermia Incidence In Operating Theatres of Kocaeli University. Turk J Anaesth Reanim. 2014;42:66-70. DOI:10.5152/TJAR.2014.15010.

11. Yokoyama K, Suzuki M,Shimada Y,Matsushima T, Bito H, Sakamoto A. Effect of administration of pre-warmed intravenous fluids on the frequency of hypothermia following spinal anesthesia for Cesarean delivery. J Clin Anesth. 2009;21(4):242–8. DOI:10.1016/j.jclinane.2008.12.010.

12. Woolnough M, Allam J, Hemingway C, Cox M,Yentis S.M. Intra-operative fluid warming in elective caesarean section: a blinded randomised controlled trial. Int J Obstet Anest. 2009;18(4):346–51. DOI:10.1016/j.ijoa.2009.02.009.

13. Rajagopalan S, Mascha E, Na Jie, Sessler DI. The Effects of Mild Perioperative Hypothermia on Blood Loss and Transfusion Requirement. Anesthesiology. 2008;108(1):71–7. DOI:10.1097/01.anes.0000296719.73450.52.

14. Yi J, Liang H, Song R, Xia H, Huang Y. Maintaining intraoperative normothermia reduces blood loss in patients undergoing major operations: a pilot randomized controlled clinical trial. BMC Anesthesiology. 2018;18:126. DOI: 10.1186/s12871-018-0582-9.

15. Xu H, Xu G, Ren C, LiuL, Wei L. Effect of forced-air warming system in prevention of postoperative hypothermia in elderly patients: A Prospective controlled trial. Medicine (Baltimore). 2019;98(22):e15895. DOI: 10.1097/MD.0000000000015895.

16. Liu S, Pan Y, Zhao Q, Feng W, Han H, Pan Z, et al. The effectiveness of air-free warming systems on perioperative hypothermia in total hip and knee arthroplasty: A systematic review and meta-analysis. Medicine (Baltimore). 2019;98(19):e15630. DOI:10.1097/MD.0000000000015630.

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